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FARMERS' BULLETIN 1078
UNITED STATES DEPARTMENT OF AGRICULTURE

# Harvesting and Storing Ice on the Farm

WHERE a stream of water or pond is available in the northern section of the United States, natural ice can be harvested and stored at low cost.

Care should be used to insure that the source of the ice supply is free from pollution and contamination.

Where very cold weather prevails in the winter and ponds and streams are not available, cans or paper sacks may be used for freezing cakes of ice.

The space used for storing ice should accommodate about 50 per cent more than is actually needed, which allows for a heavy shrinkage and for general household purposes.

A cubic foot of ice weighs about 57 pounds. About 45 cubic feet of space should be allowed ordinarily for storing a ton of ice.

Under ordinary circumstances from about ½ to 1 ton of ice per cow is needed annually for cooling cream and from 1½ to 2 tons for cooling milk on a dairy farm.

Contribution from the Bureau of Animal Industry
JOHN R. MOHLER, Chief
Washington, D. C. January, 1920

# HARVESTING AND STORING ICE ON THE FARM.[1]

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CONTENTS.



## THE SOURCES OF ICE.

WATER for the ice supply should be free from contamination or pollution. Ponds and sluggish streams usually have grass and weeds growing in them so that ice harvested from them may contain decayed vegetable matter, which is always an objectionable condition and may be injurious to health. These should, therefore, be thoroughly cleared of such growth before cold weather. Green spawn and algæ may be destroyed by the use of copper sulphate (blue vitriol). The crystals can be placed in a cloth bag which is hung on the end of a pole and trailed through the water until all the crystals are dissolved. One or two treatments during the summer season at the rate of 1 pound of copper sulphate to 13,000 cubic feet of water will be sufficient to keep down such growths.

Careful investigation should be made to determine whether the source of ice supply is pure and free from contamination or pollution. Streams or lakes are often polluted by sewage or other impurities which it is impossible to eliminate. A pure ice supply is especially important when the ice is to be used directly in beverages or other foods.

Throughout a considerable area of the United States natural ice is formed during the winter months in sufficient quantity to warrant

NOTE.—Acknowledgment is made to the Division of Rural Engineering, Bureau of Public Roads, for collaboration and assistance in the preparation and revision of the text matter and drawings of this bulletin.

[1] A revision of Farmers' Bulletin 623, "Ice Houses and the Use of Ice on the Dairy Farm."

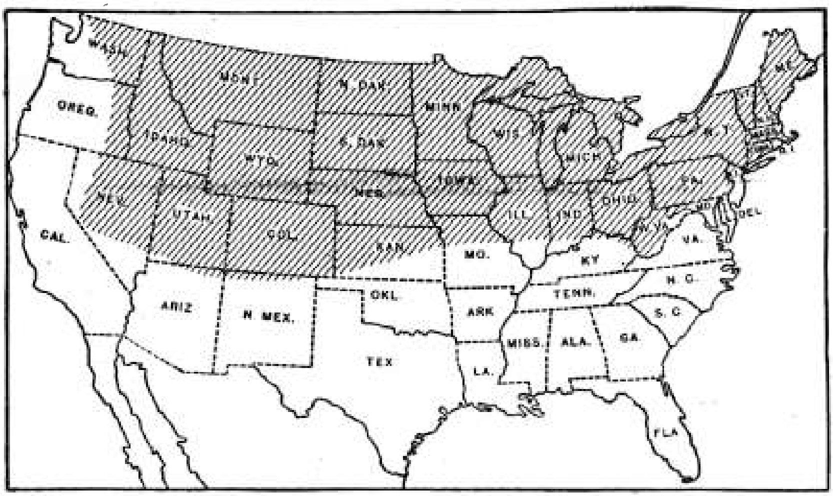


FIG. 1.—Map of the United States, showing region in which natural ice may be harvested in normal winters.

harvesting and storing (fig. 1). In many sections of this area are lakes, ponds, and streams from which ice can be harvested, while in others it is necessary to create artificially a suitable body of water for producing ice. This may be done either by excavating and diverting a stream into an excavation or by constructing dams across low areas. When it is necessary to construct artificial ponds the surface area is usually limited and several cuttings are ordinarily necessary to obtain the quantity of ice needed. (Figs. 2 and 3.)

FIG. 2.—Artificial pond in yard.

When cold weather prevails for several weeks at a time and the supply of pure water is limited, a method of freezing ice in metal cans or special paper bags may be used. The cans may be made in any convenient size by a local tinsmith and should be of galvanized iron reinforced at top and bottom with iron strips. The bottom is made smaller than the top, to make the removal of the ice easier. The cans are placed near the water supply, filled with water, and left exposed to the weather. A shell of ice soon freezes around the inner surface, and when the shell is from 1½ to 2 inches thick, hot water is poured over the outside of the can and the shell removed. A hole is broken through at the top of the shell and most of the water inside is then poured out. As the freezing progresses water is poured into the shell a little at a time until a solid block of ice is produced. By this method only a few cans are required, which keeps the cost low.

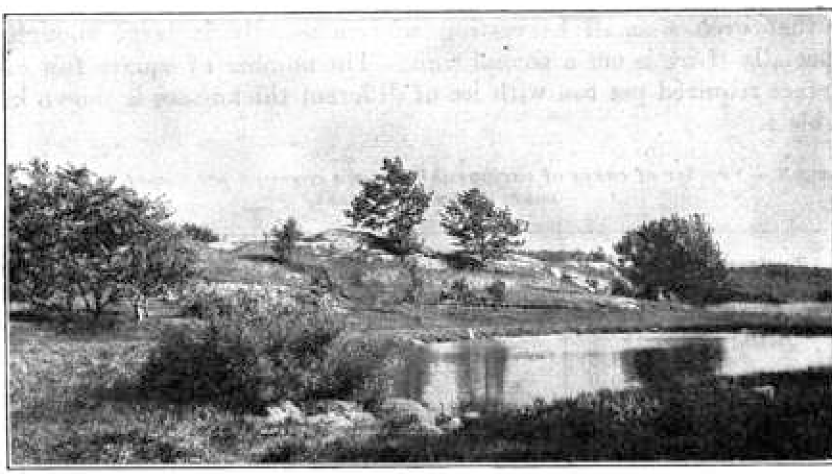

FIG. 3.—Natural pond.

About the same method is employed when special paper bags are used, although they do not last so long as the cans. The advantage of the bags over the metal cans is mainly in cheapness, for they are not so convenient to handle.

Another method that can be used in very cold sections of the United States is to run water into the ice house and let a layer freeze. This is done by first constructing a dam of snow around the floor of the house 10 or 12 inches from the walls in order to allow sawdust insulation next to the walls. The interior of the house is then flooded with a few inches of water, which soon freezes, the procedure being repeated until the house is filled with ice. It is then covered with sawdust and closed up until ice is needed. A great disadvantage of this method is that in order to remove ice it must be cut or chopped out with an ax, which results in uneven and irregular pieces and considerable waste of ice.

Floe ice is another source of natural ice. It is obtained in the spring when large chunks or pieces of ice float down from the headwaters of streams and rivers. This ice is always broken up into irregular pieces and is not so easily handled and packed as that which is cut in regular shape.

## HARVESTING ICE.

### SIZE OF ICE FIELD.

When the field is of sufficient size to fill the ice house at a single cutting, the thickness and quality of the ice is more nearly uniform and preparation for cutting and harvesting need be made but once. In many instances, however, the small size of the pond or stream makes it necessary to wait for a second crop in order to fill the ice house. The average dairy requires only a moderate quantity of ice, so that even a small harvesting surface usually is large enough, especially if ice is cut a second time. The number of square feet of surface required per ton with ice of different thicknesses is shown in Table 1.

TABLE 1.—*Number of cakes of various thicknesses required per ton of ice (size of cake, 22 by 22 inches).*

| Thickness of ice. | Number of cakes required per ton. | Cutting space required per ton. | Thickness of ice. | Number of cakes required per ton. | Cutting space required per ton. |
|---|---|---|---|---|---|
| *Inches.* | | *Square feet.* | *Inches.* | | *Square feet.* |
| 4 | 31.3 | 105.4 | 14 | 8.9 | 30.1 |
| 6 | 20.9 | 70.2 | 16 | 7.8 | 26.3 |
| 8 | 15.6 | 52.6 | 18 | 6.9 | 23.4 |
| 10 | 12.5 | 42.1 | 20 | 6.3 | 21.1 |
| 12 | 10.4 | 35.1 | 22 | 5.7 | 19.1 |

### REMOVING SNOW FROM SURFACE.

Where it is not advisable to wet the surface of the ice field and thus hasten the freezing, the snow should be scraped from the surface of the ice, since snow acts as insulation and retards freezing. If the ice is thick enough to bear the weight of a horse the snow may be removed easily with a scraper, such as is shown in figures 4 and 5. On small ponds the snow may be scraped on to the shore, but on large fields, especially if the snow is deep, it is impracticable to scrape it entirely off the fields. It becomes necessary therefore to pile it in windrows. Windrows of snow, of course, occupy considerable space, so that it is necessary to allow for an increased area of ice.

The distance between the windrows depends upon the depth of the snow. It is advisable, however, to run them at right angles to the main channel through which the ice is floated. The area between the

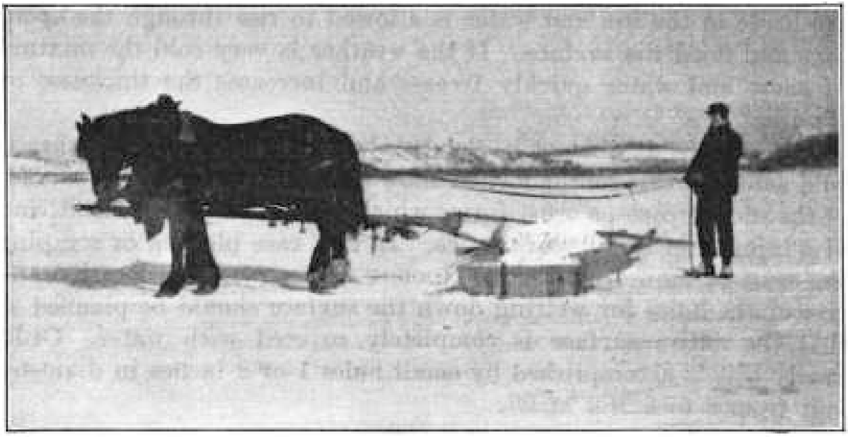

FIG. 4.—Scraping snow from ice field.

windrows then can be cut back any distance from the main channel, whereas if they run parallel to the main channel only that portion of the surface between can be cut before opening another channel. As the weight of the windrows of snow is usually sufficient to make the ice on which it is piled sink beneath the surface of the water, it is advisable, in order to prevent the water from overflowing the cutting surface, to cut a deep groove, or to cut through the ice parallel to and on both sides of the windrows.

### WETTING DOWN THE FIELD.

Usually snow falls on the ice before it is thick enough to harvest. Since the weight of the snow has a tendency to sink the ice, advan-

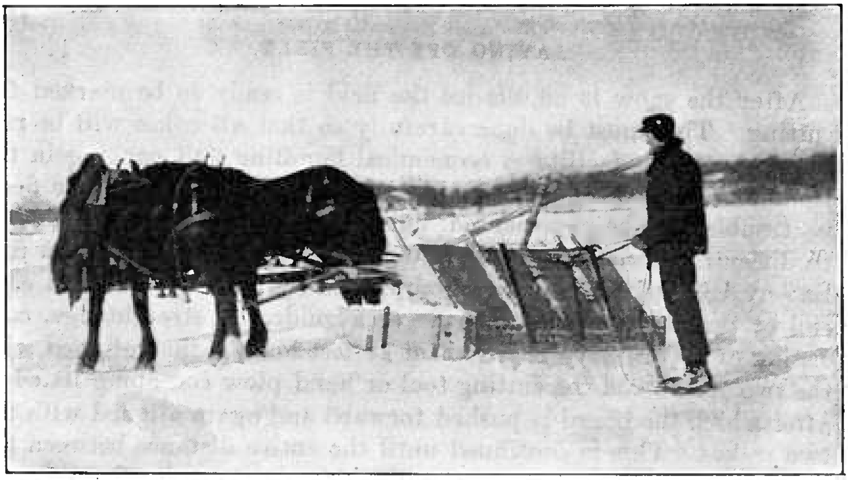

FIG. 5.—Dumping snow from scraper.

tage is sometimes taken of the layer of snow in forming ice. Holes are made in the ice, and water is allowed to rise through the openings and flood the surface. If the weather is very cold the mixture of snow and water quickly freezes and increases the thickness of the ice.

The surface should not be flooded, however, unless the weather is cold enough to freeze the melted snow solid. If only the top surface of the snow freezes, a crust forms which makes scraping difficult, and also injures the quality of the ice. In that case planing or scraping the crust of snow from the ice becomes necessary. The location and size of the holes for wetting down the surface should be planned so that the entire surface is completely covered with water. Ordinarily this is accomplished by small holes 1 or 2 inches in diameter and from 6 to 8 feet apart.

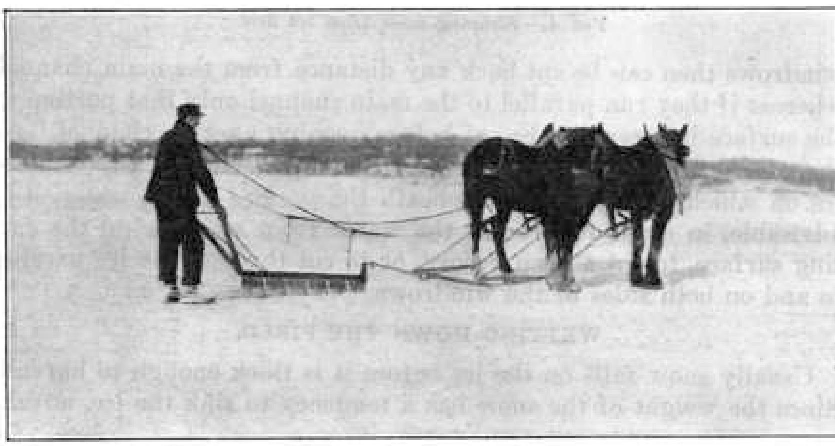

FIG. 6.—Plowing ice.

### LAYING OFF THE FIELD.

After the snow is off the ice the field is ready to be marked for cutting. This must be done carefully so that all cakes will be rectangular, which facilitates economical handling and packing in the ice house. If a proper beginning is made in marking off the field, no trouble will be experienced, but if not, subsequent cuttings will be difficult. Success in marking depends largely on getting the first line straight, which may be accomplished by placing a stake at each end of the proposed line to serve as a guide. A straightedge, consisting of an ordinary board about 14 feet long, is then aligned with the two stakes and the cutting tool or hand plow run along its edge, after which the board is pushed forward and again aligned with the two stakes. This is continued until the entire distance between the stakes has been covered. Another way is to stretch a line between the

stakes and do the marking with a hand plow, but this method is not so satisfactory, because the hand plow can not be run in so straight a line without the aid of the straightedge. After the first line is cut to a sufficient depth it can be used as a guide for the horse marker (fig. 6) if this tool is used.

After the field has been lined off in one direction the crosslines should be made. Care should be taken to have the crosslines at right angles to those first drawn, which is accomplished by the use of a square. A square suitable for the purpose can be made easily. First nail the ends of two boards together with a single nail. Measure a distance of 8 feet on the outer edge of one board and 6 feet on the outer edge of the other, then nail a third board diagonally across the

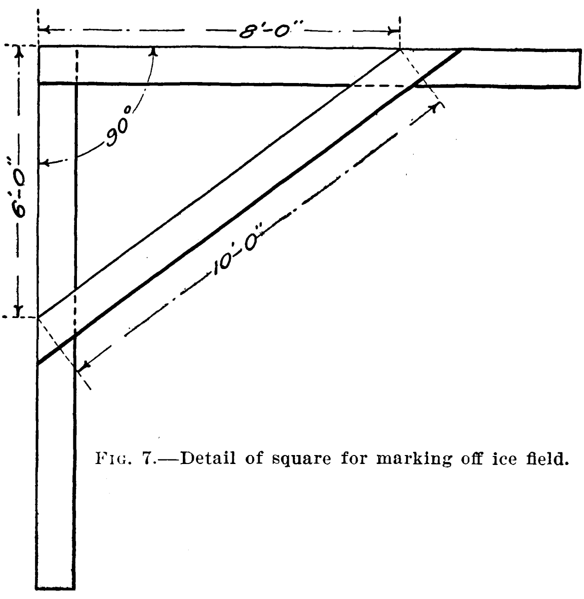


FIG. 7.—Detail of square for marking off ice field.

two, adjusting it until the two marks are exactly 10 feet apart on a straight line. The boards should then be nailed together securely, forming the desired square as shown in figure 7. If the first crossline is drawn with care it is easy to draw the remaining lines parallel.

## SIZE OF CAKES.

The size of the cakes depends to some extent on the thickness of the ice, as well as upon the tools available for harvesting, but in any case it is important to have all the cakes of the same size. In order to simplify the handling and packing, many farmers, especially those who harvest a comparatively small quantity of ice, cut the cakes 22 inches square, a size that is easily handled with a limited amount of equipment. Table 1 gives the number of cakes 22 inches square and of different thicknesses required for each ton of ice.

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In the case of floe ice, which is always broken up, it is of course impracticable to obtain cakes of uniform size; consequently it is gathered and packed as well as possible. The ice axe is used to remove irregular corners and the small pieces are used to fill the holes around the irregular pieces in order to make the whole as solid as possible and to reduce to the minimum the quantity of entrapped air.

### CUTTING.

After the field has been marked off, a strip of ice, one block in width (22 inches) and extending from the loadingway to the main channel, is cut through and forced under the surface of the surrounding ice. This strip should be sawed somewhat wedge-shaped, wider

FIG. 8.—Sawing out floats.

at the bottom than at the top, which allows it to be forced down under the field with ease. The operation is known as "sinking the header" and it opens up a small channel the width of the proposed cakes. The channel is widened by cutting another strip to enable the long strips or floats of ice to be floated from the main channel to the bank or loadingway.

The strips of ice are then pushed with an ice hook along the channel to the bank or loadingway, where they are sawed or chopped into cakes. (See figs. 8, 9, and 10, and illustration on cover.) The narrow channel, cut at right angles to the main channel, has the advantage of allowing the operator to get closer to the cakes and to handle them more easily. At the end of the narrow channel there should be an

FIG. 9.—Cutting the ice.

inclined track or loadingway up which the cakes are drawn either by hand or by a horse. (See figs. 11, 12, and 13.) This track may lead directly into the ice house or to a platform from which the cakes are loaded upon a wagon or sled.

The cakes should not be cut completely through, but should be grooved 2 or 3 inches deep with the plow, and after being floated up

FIG. 10.—Floating large cakes of ice to shore to be cut into smaller ones.

the channel chopped through with a special tool before being put on the loadingway. This practice saves labor and time.

## PACKING.

Loss of ice by melting depends partly upon the manner of packing. The cakes should be placed close together so that the mass will

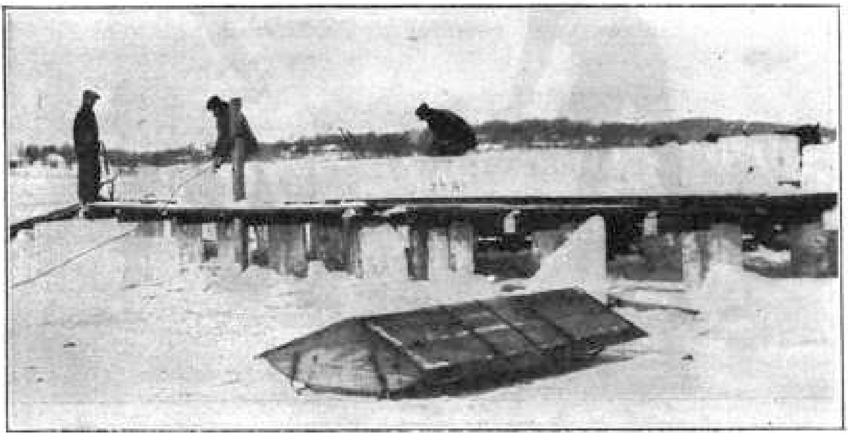

FIG. 11.—Drawing ice cakes from water to loading platform.

be as tight and solid as possible, thus preventing cracks and openings that will allow air to circulate. Perfectly cut rectangular cakes can be closely packed, which emphasizes the importance of special care in cutting to insure cakes of exactly the same size. When they are

FIG. 12.—Harvesting and loading ice.

irregular in size the best plan is to fill up the openings with small pieces of ice in order to make the mass as tight and compact as possible. In order to insure close contact between succeeding layers no broken ~~ice should be allowed to remain~~ on top of or to protrude above the ice cakes.

In the beginning a layer of dry sawdust about a foot thick should be placed in the bottom of the ice house, the depth of the sawdust being a few inches less in the center than at the outer edge, so that the cakes will have a tendency to slide toward the center instead of toward the walls. The sides of the mass of packed ice should be smooth. Any projecting pieces should be trimmed off before the mass is covered with insulation. If sawdust or mill shavings are used a space of at least 12 inches must be left between the sides of the ice stack and the walls of the building. This space is filled with dry sawdust or shavings as the packing in the center proceeds.

In packing small quantities of ice it is a common custom to pour water over the stack or mass of packed ice and allow it to freeze solid before putting the insulation in place. While undoubtedly this pro-

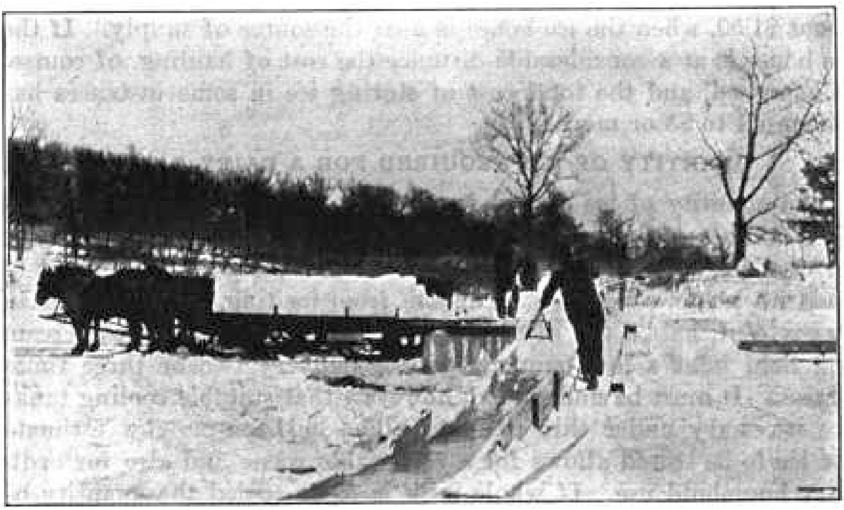

FIG. 13.—Loading cakes of ice on sleds for hauling to ice house.

cedure assists in reducing the melting by closing the openings between the cakes, it has the disadvantage of making it more difficult to remove the ice when needed. It is then necessary to chop the cakes apart, which wastes considerable ice, so that little is gained in this way.

## TOOLS REQUIRED.

When a small quantity of ice is to be harvested few tools are required. The following list contains those actually needed: Two ice saws, 1 hand marker, 1 pulley and rope, 2 pairs of ice tongs, 2 ice hooks, 1 pointed bar or splitting fork, and 1 straightedge. Besides these essential tools, additional ones, such as a horse plow and marker, horse scraper, and a calking bar are convenient and will help to expedite the work. The amount of the equipment depends on the quantity of the ice to be cut and on local conditions for handling ice. If

the harvesting must be done quickly, to take advantage of the weather, extra equipment will be justified. Neighbors may cooperate advantageously in cutting and storing their ice and in owning equipment jointly.

### COST OF HARVESTING ICE.

The cost of harvesting ice also varies with local conditions. It is impossible, therefore, to give an estimated cost that will cover all cases. The ice-harvesting season fortunately comes at a time when there is the least work on the farm for men and teams, and consequently the actual money cost is usually not very great. Investigations have indicated that counting the full value of the men's time, the average cost of cutting ice is about 3 cents for a cake 22 inches square and 14 inches thick, or about 27 cents a ton. Add to this the cost of packing and hauling, and the average cost of a ton of ice is about $1.50, when the ice house is near the source of supply. If the ice house is at a considerable distance the cost of hauling, of course, is increased, and the total cost of storing ice in some instances has amounted to $3 or more a ton.

### QUANTITY OF ICE REQUIRED FOR A DAIRY FARM.

The quantity of ice needed for a dairy farm depends on its location, number of cows milked, and methods of handling the product. In the Northern States it has been found that with a moderately good ice house, where the shrinkage from melting is not more than 30 per cent, half a ton of ice per cow is sufficient to cool the cream and hold it at a low temperature for delivery two or three times a week. It must be understood, however, that suitable cooling tanks are necessary under this estimate. The half-ton-per-cow estimate for ice to be stored allows for a reasonable waste and also for ordinary household use. If whole milk is to be cooled the quantity of ice stored must be increased to 1½ tons per cow in the North and 2 tons per cow in the South. To meet the needs of the average family on a general farm it will be necessary to store about 5 tons.

## ICE HOUSES.

### CAPACITY OF ICE HOUSES.

A cubic foot of ice weighs about 57 pounds, so in storing ice it is customary to allow from 40 to 50 cubic feet per ton for the mass of ice, but the quantity that an ice house of a given size will hold depends upon the manner in which the ice is stored. Generally a cubic foot of an ice house will hold the quantities given below:

| | Pounds. |
|---|---|
| Ice thrown in at random, about | 30 to 35 |
| Ice thrown in in irregular pieces and broken sufficiently to pack closely | 35 to 40 |
| Ice piled loosely | 40 to 45 |
| Ice piled closely and with very slight crevices between | 45 to 50 |

Unless the ice house has permanently insulated walls, at least 12 inches must be left between the ice and the wall of the building for insulation, and an equally large space for insulation must be allowed beneath and above the ice. From this it is possible to calculate readily the quantity of ice that any given house will hold. Thus, allowing 45 cubic feet per ton, an uninsulated ice house 18 by 12 by 10 feet high, allowing 1 foot around the ice for insulation, will hold about 38 tons, while the same-sized house if insulated will hold about 43 tons.

Loss by melting is in proportion to the surface area exposed to the air or packing material; hence it is advisable to store ice in the form of a cube, or as nearly so as possible. However, a square ice house without a gable roof is not desirable because its capacity is not so great as that of a square house of equal cubical content up to the plate line and roofed with a gable. A gable roof allows of a greater height of the filling door, thus permitting the storage of a larger quantity of ice, and affords better ventilation and ease of handling. Table 2 gives the inside dimensions of insulated houses for various quantities of ice. For uninsulated houses the dimensions should each be increased 2 feet.

TABLE 2.—*Inside dimensions of insulated ice houses for various quantities of ice.*

| Quantity of ice. | Length. | Width. | Height. |
|---|---|---|---|
| *Tons.* | *Feet.* | *Feet.* | *Feet.* |
| 10 | 10 | 7 | 7 |
| 20 | 14 | 8 | 8 |
| 25 | 14 | 10 | 8 |
| 30 | 14 | 10 | 10 |
| 40 | 18 | 10 | 10 |
| 50 | 16 | 12 | 12 |

## LOCATION.

The selection of a site for an ice house is very important. Other conditions being suitable, the ice house on a dairy farm should be placed as near as possible to the milk house, in order to reduce the labor of handling and to encourage the more liberal use of ice. On a general farm the ice house should be located near the residence. To facilitate drainage the ground on which the ice house stands should be porous and slope from the building. Advantage also may be taken of the nearness of hills, trees, or buildings, which often afford protection from hot winds, thus saving ice.

## ICE PITS.

If a suitable, well-drained location is available and only a small quantity of ice is to be stored, a pit may be used to advantage for

storing ice. (See fig. 14.) The site selected should be sloping in order that a drain may be placed under the floor of the house. This drain may be of porous tile or may be simply a trench packed with small stones or gravel. If a tile drain is installed it should be properly trapped to prevent the entrance of warm air into the pit. The trap should be placed outside of the building where it will be accessible in case the drain becomes clogged. The trap may be placed where the drain discharges upon the ground but as a stoppage may occur between the building and the trap it is better to

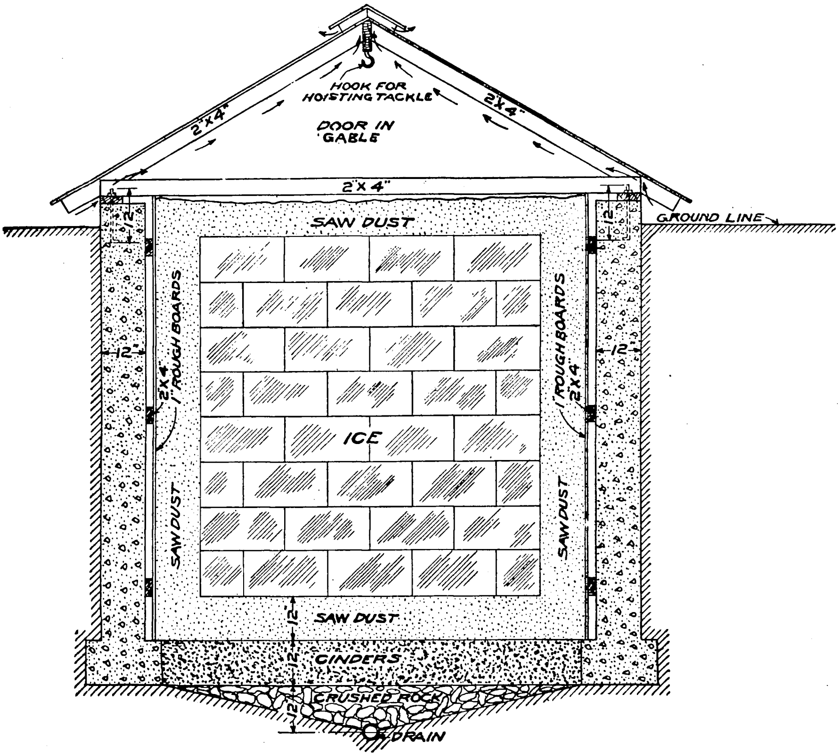


FIG. 14.—Underground ice house.

place it close to the foundation wall. The trap should be of the handhole type with a terra-cotta stopper made air-tight with a light pointing of cement which may easily be removed when necessary. The drain should not be laid near trees, as the tree roots will find their way to the drain, causing a stoppage in a very short time. The purpose is to provide adequate drainage; otherwise the bottom of the pit will be flooded with water from melted ice or from seepage.

The floor of an ice pit should consist of 12 inches of crushed rock or coarse gravel tamped into place, on top of which are 12 inches of cinders also well tamped. The walls should be 12 inches thick made

of concrete mixed in the proportion of 1 part of Portland cement to 3 of sand and 5 of crushed stone or gravel. Waterproofing the walls is unnecessary, since provision for drainage is made in the bottom of the pit. No ceiling is required, and the roof may be constructed as shown in figure 14. The door will be needed in the gable.

Drainage inside the pit is provided by sloping the floor toward the center and having the water pass into the tile or gravel drain already described.

## ICE-HOUSE CONSTRUCTION.

The construction of the ice house depends to a great extent upon local conditions, the size of the house, and the difficulty of obtaining ice. These factors help to determine the sum that may wisely be spent for such a building. Where ice is expensive or hard to obtain, a better constructed and insulated and therefore more expensive ice house is advisable. Where natural ice can be harvested and stored cheaply a cheap structure is usually satisfactory and the loss from melting ice is a small consideration.

The cost of harvesting and storing, the interest on the money invested, and repairs and depreciation on the building are to be considered in relation to the ice loss from melting; and the type of house to be built depends upon these factors. It never pays to build permanently in other than a substantial manner, and careful thought should be given the matter before erecting a cheap makeshift that will not give adequate service.

## INSULATION.

An ice house should be built where it will be shielded as much as possible from the wind and from the direct rays of the sun. The object is to prevent the outside heat from passing into the interior and melting the ice; consequently every effort must be made to resist the passage of heat by placing in the walls a material or a form of construction which will reduce the transfer of heat from the outside to the inside. No material known will entirely prevent the passage of heat, but several, called nonconductors or insulators, offer a high resistance to its passage. The best insulators appear to be those that contain entrapped air in the greatest number of small spaces. Their value also depends upon the density to which they are packed; if too loosely they will permit air circulation, if too closely they will cause the conduction of heat to a greater degree. Most of the materials in use give the best results when packed to a density of from 8 to 10 pounds per cubic foot.

Formerly in constructing buildings for the storage of ice or for cold storage, a space as much as 12 inches wide was provided in the

walls. It has been found, however, that an air space 1 inch wide is practically as valuable as one 12 inches wide. Air circulation is useful between the insulated ceiling and the roof of the ice house, for there it tends to break up the heat radiation through the roof. No openings in the ice chamber permitting entrance or exit for air, especially at or near the ground line, should be allowed in a building where ice is stored, as the cold currents of air tend to filter to the outside. If the walls and foundations are kept absolutely tight at the bottom an opening at the top has little effect, because the warm air entering remains at the top of the room. When ice is to be removed from the house, the door should be kept open as short a time as possible, and if a covering material, such as sawdust, is used, it is important to replace it after the ice has been removed. In a properly insulated ice house no covering for the ice is needed. It is merely packed on the floor of the room and depends on the insulated walls for protection from the outside heat.

In the cheaper ice houses, which do not have properly insulated walls, sawdust or mill shavings are commonly used to protect the ice. A layer of that material should be placed on the floor to a depth of about a foot and the ice stacked upon it, a layer at a time. Ice will melt rapidly if placed directly on the ground, because moist ground is a fairly good conductor of heat. Sawdust and shavings, it may be explained, are not the best insulators for this class of building, but are used because they are cheap, are available in many parts of the country, and if kept dry are good insulators. As it is difficult to keep them dry, however, great care should be used in the construction of the walls in order to exclude moisture. The outer wall covering should be practically air-tight, since if it is not, moisture will find its way in with the air, flow through the filling material, and condense on the cold inner wall. The result is the gradual saturation of the insulating material and its consequent loss of value as an insulator.

For insulating purposes planing-mill shavings are better than sawdust, because they are elastic, do not settle so readily, do not absorb moisture so rapidly, and are free from dirt, bark, and chips. When used as filling for walls or ceiling they should be well packed into place to prevent settling. Sawdust has been in common use for insulating because it usually could be obtained easily and at little or no cost. It has the disadvantage, however, of nearly always being damp, a condition which destroys its insulating value and favors the growth of mold and rot both in the sawdust and in the walls of the building. The rotting generates heat and also causes the sawdust to settle, thus leaving open spaces which further decrease the insulation. When sawdust is to be used it should be dried thoroughly before it is put into place. It can be dried by spread-

ing out to a depth of about 6 inches and exposing it to the air and sunshine for a few days. Stirring will hasten the drying.

There are several kinds of commercial insulation which are much more effective than either sawdust or shavings, and while their first cost is somewhat greater, in the end they are usually cheaper. Their insulating value is uniform and moisture has little effect on them. In addition they are practically fireproof, occupy little space, and retain their efficiency a long time. Experienced workmen must install such insulation if best results are to be obtained.

### DRAINAGE.

Good drainage is essential for satisfactory ice storage. In houses where the floor is below the ground level drainage enough usually can be obtained through the soil if it is porous. With a clay soil it may be necessary to excavate a foot or two and fill it with gravel or

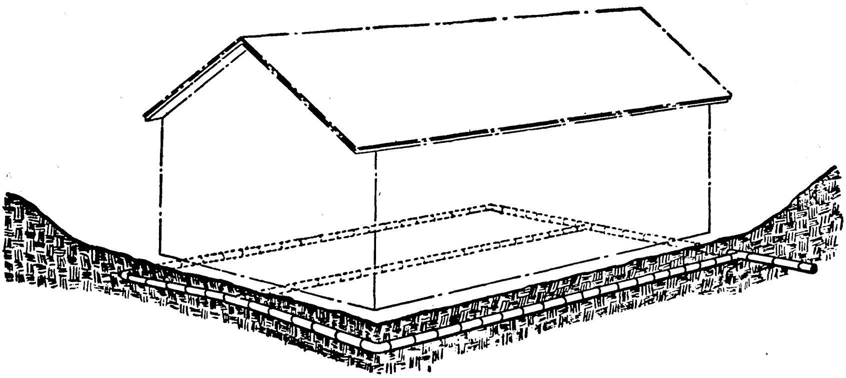

FIG. 15.—Tile drain and foundation walls.

cinders or to place a 3-inch porous tile drain under the floor. The drain should be trapped or sealed outside of the walls to prevent warm air from entering the building through the floor. Dry soil affords better insulation than wet earth; hence it is advisable, where subsurface water is likely to keep the ground under the house damp, to lay a tile drain around the outside of the foundation walls (fig. 15). In place of the tile a drain may be made of crushed rock and gravel, packed in a manner similar to that described under ice pits.

As in the case of pits, the floor of the ice house should slope toward the center to keep the ice in a campact mass and to carry the water to the drain.

### VENTILATION.

Whatever the construction of the building, there is certain to be more or less melting that will cause moisture to appear on the walls and ceiling. If the building is of wood the moisture is absorbed by

the wood and decay follows. Wooden ice houses, therefore, should have a means of ventilation which can be controlled and the ceiling should slope to the center to assist circulation and carry warm, moisture-laden air to the ventilator. A house equipped with commercial insulation, that is, covered inside with a cement finish, needs no ventilators from the ice chamber, but as shown in the plans (fig. 21a) the building should be so constructed as to afford a circulation of air through the outer walls and from the eaves to the ventilator on the roof. The resulting air currents tend to break up the heat radiation through the walls and roof.

### WATERPROOFING.

It is of great importance that brick, concrete, and wooden buildings be waterproofed on the inside. Brick and concrete may be readily waterproofed by painting the walls with a suitable paint or waterproofing compound, such as preparations of paraffin and asphalt. Paraffin and asphalt should be applied hot and in addition the walls should be heated before the application. There are on the market several water-excluding paints and compounds for preserving wood. Creosote is considered one of the best preservatives provided the wood is thoroughly impregnated with it, but on account of its odor it is objectionable in houses where food products are stored.

## GENERAL SPECIFICATIONS FOR VARIOUS TYPES OF ICE HOUSES.

### POST ICE HOUSE, UNINSULATED.

**Floor.**—Consists of 12 inches of coarse gravel tamped into place as shown in figure 16.

**Walls.**—Posts about 3 feet center to center are set up as indicated in figure 16, extending 3 feet into the ground and capped by a plate made of two pieces of 2 by 4 inch material; the inside is sheathed with 1-inch boards. The posts and boards below the ground should be treated with some preserving compound.[1]

**Ceiling.**—No ceiling is provided.

**Roof.**—The type of roof used is shown in figure 16.

**Doors.**—A door may be provided by cutting out the boards between two posts in the end of the house and closing the opening by placing short boards across on the inside and packing sawdust against them to keep them in place.

**Drainage.**—Drainage is obtained by sloping the floor of the house so that the water will run to the center. A ditch should be dug as indicated, and filled with gravel and small stones. This ditch should empty outside at a point where there is sufficient fall to carry the water away. A 3-inch porous drain tile may be provided, as shown in figure 17. It should be properly trapped to prevent the entrance of warm air.

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[1] For information in this connection reference is made to Farmers' Bulletin 744, entitled "The Preservative Treatment of Farm Timbers."

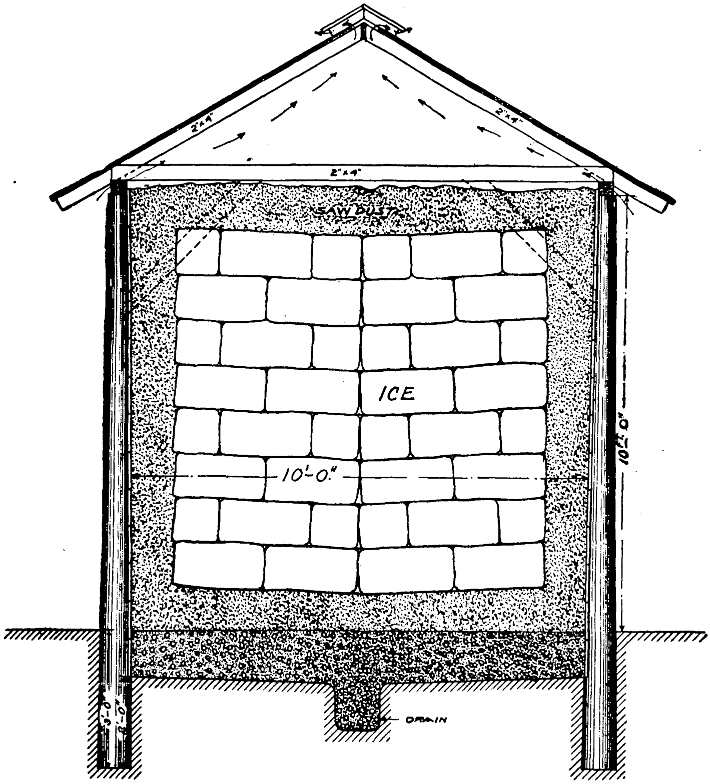



FIG. 16.—Post ice house, uninsulated.

## FRAME ICE HOUSE, UNINSULATED.

**Floor.**—Consists of 12 inches of coarse gravel tamped into place, as shown in figure 17.

**Walls.**—On a 2 by 10 inch mudsill 6 by 6 inch sills are placed with 2 by 4 inch studs spaced about 2 feet center to center; on the inside of the studs 1-inch boards are nailed. The studding is capped as indicated. Both mudsills and sills should be treated with creosote.

**Ceiling.**—No ceiling is provided.

**Roof.**—The type of roof used is shown in figure 17.

**Doors.**—A door may be provided as suggested for the post ice house.

**Drainage.**—Drainage is provided by sloping the floor toward the center. Either a ditch such as is described under post ice house or a 3-inch porous drain tile may be used to carry off the water. The same requirements are necessary as in the post ice house.

## OPEN-TYPE ICE HOUSE, UNINSULATED.

Figure 18 illustrates a small frame ice house such as is recommended by the Rochester (N. Y.) health board.

**Floor.**—Should consist of 12 inches of crushed stone or coarse gravel well tamped into place.

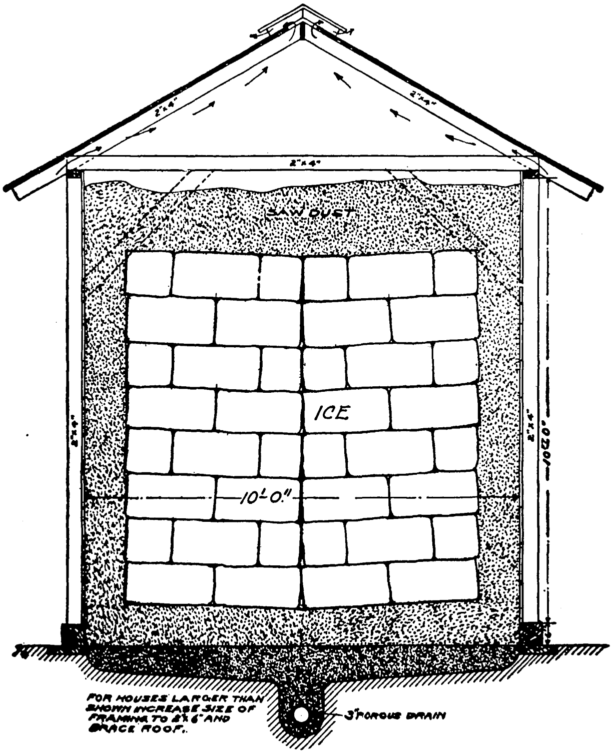



FIG. 17.—Frame ice house, uninsulated.

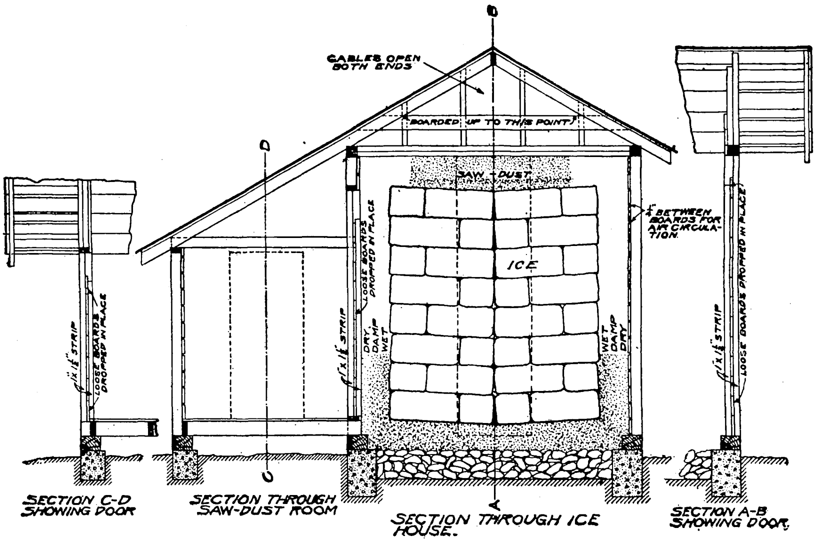



FIG. 18.—Open type ice house.

**Walls.**—The walls consist of 2 by 4 inch studs spaced about 2 feet center to center and erected on 6 by 8 inch sills. On the inner side of the studs are placed 1-inch rough boards with a ¼-inch space between. The object of the open construction is to dry out the outer layers of sawdust around the ice.

**Ceiling.**—No ceiling is provided. The gables are left open to permit circulation of air over the ice.

**Doors.**—Doors are constructed as shown and consist of loose boards dropped into place.

**Drainage.**—Drainage is provided by sloping the floor toward the center of the house. If the house is built on porous soil no drain will be needed; otherwise one of the forms of drainage described under post ice house should be used.

**Roof.**—The roof is constructed as shown in figure 18 with an overhang of about 2 feet to prevent rain from blowing in on the top of the ice.

**Sawdust room.**—A storage room for sawdust should be constructed as shown in figure 18.

## WOODEN ICE HOUSE, INSULATED WITH SAWDUST OR MILL SHAVINGS.

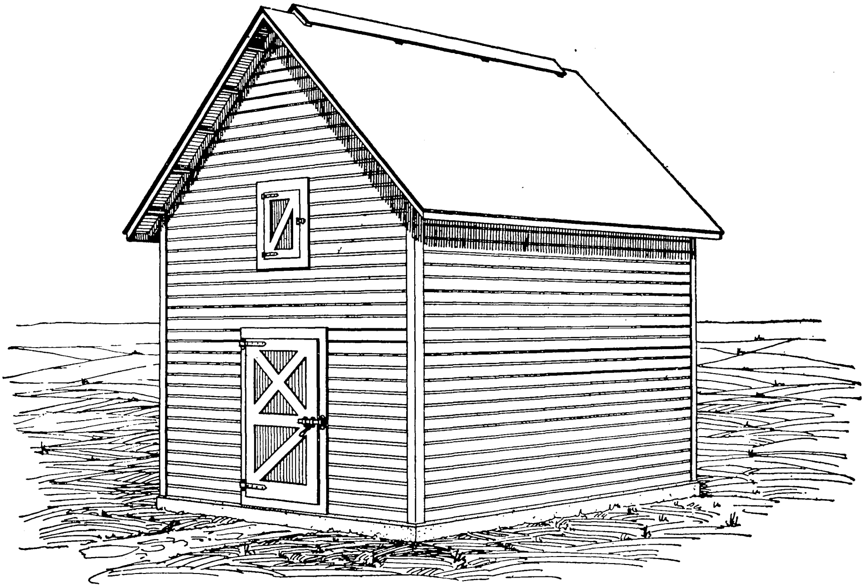


FIG. 19.—Wooden ice house, insulated with sawdust or mill shavings. (Perspective view.)

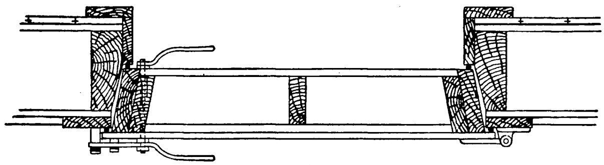
Figures 19 and 20 illustrate an ice house with and without a milk room.

**Framing.**—All framing should be dried, square edged, sawed fair and full to the sizes given, and should not contain any of the following defects: Wormholes, shakes, heart pith, warped, twisted, or unevenly sawed lumber, and unsound knots. The sizes used are shown in the various figures.

**Boards.**—All boards used should be thoroughly dried and free from loose knots, heart centers, shakes, or splits, should be dressed, tongued-and-grooved, and all unsound boards rejected.

**Paper.**—Only heavy waterproofed insulating paper should be used. Ordinary building paper is not satisfactory. Double thickness of paper is used in all cases, each layer lapping 6 inches over the preceding one. The layers extend continuously around all corners, and breaks should be carefully covered.

**Insulation.**—When shavings or sawdust are used they should be thoroughly dried and free from dirt, chips, and bark and be well packed into place. When commercial insulation is used and installed by the manufacturers it is usually guaranteed not to transmit more than a certain amount of heat under given conditions.



DETAIL OF DOOR

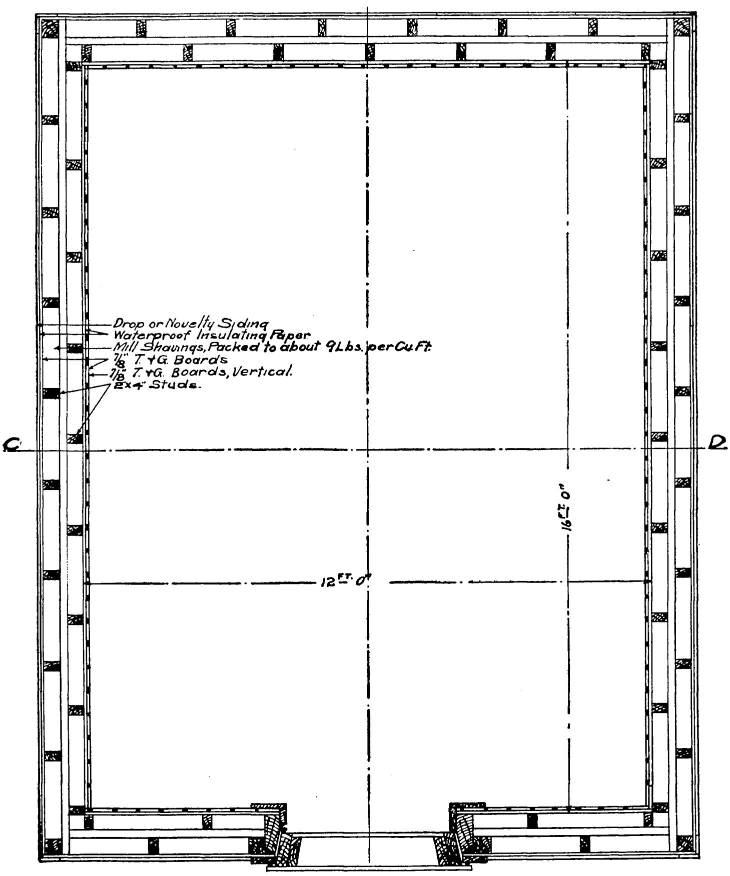



FIG. 19A.—Wooden ice house, insulated with sawdust or mill shavings.

**Carpenter work.**—This always should be executed in a substantial and workmanlike manner.

**Excavating and grading.**—To get a firm and solid footing the area should be excavated for the floor and foundation. The entire floor should be graded to the level shown in figure 19b, and rolled and tamped until solid.

**Foundation.**—Footings should be of stone or concrete of the size shown in figure 19b and of sufficient depth to insure a solid foundation.

**Floor.**—If obtainable, coal cinders should be used in preference to sand, gravel, or crushed rock to cover the ground area of the building. The depth

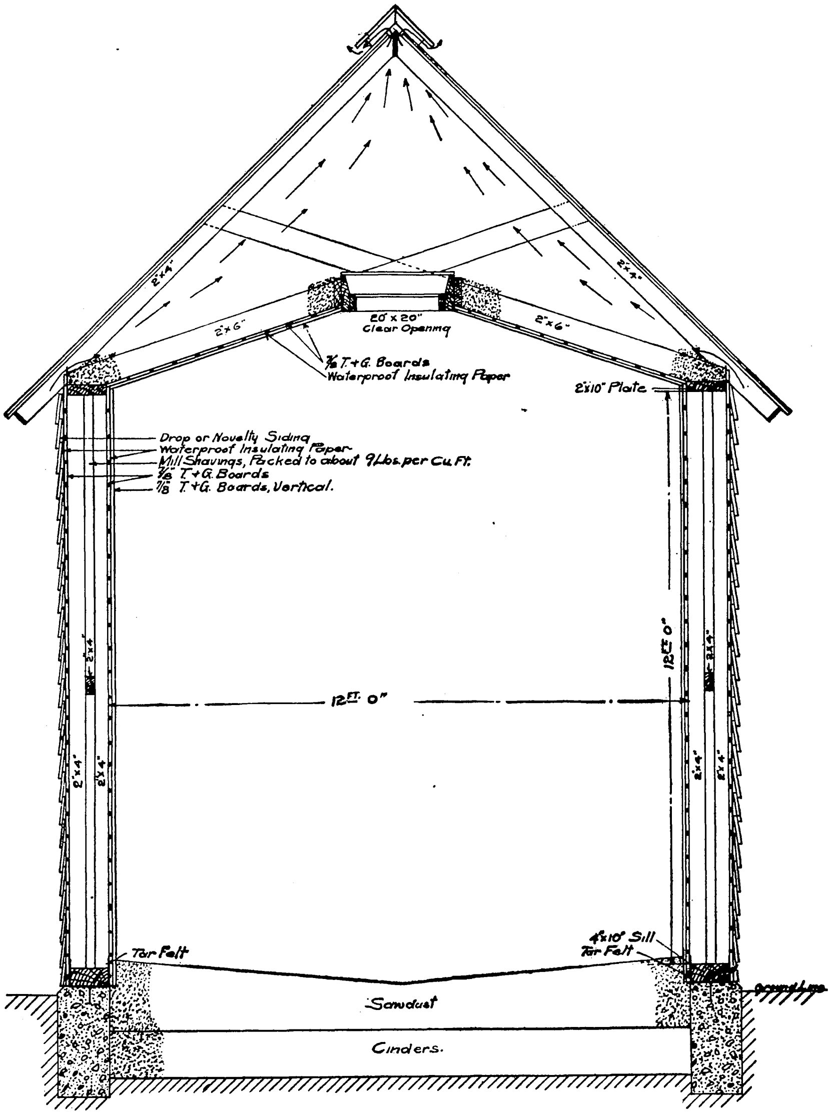



FIG. 19B.—Wooden ice house, insulated with sawdust or mill shavings. (Section on *C–D* of fig. 19a.)

of the layer of cinders which forms the floor is 12 inches and the cinders should be well tamped into place.

**Walls.**—Double rows of 2 by 4 inch studs should be staggered with one 2 by 4-inch tie, as shown in figure 19b. These are covered on the outside with one

layer of ⅞-inch tongued-and-grooved boards. On the outside of this, two layers of waterproofed insulating paper are placed and this covered with a good quality of ship-lap siding. For the inside of the room one layer of tongued-and-grooved boards is laid directly on the studs, then two layers of insulating paper and finally a course of ⅞-inch tongued-and-grooved boards. The insulating paper should extend continuously around the corners and be lapped at least 6 inches.

**Ceiling.**—The ceiling is constructed as shown in figure 19b, with one course of ⅞-inch matched boards nailed to joists, then two layers of waterproofed insulating paper followed by a course of ⅞-inch tongued-and-grooved boards.

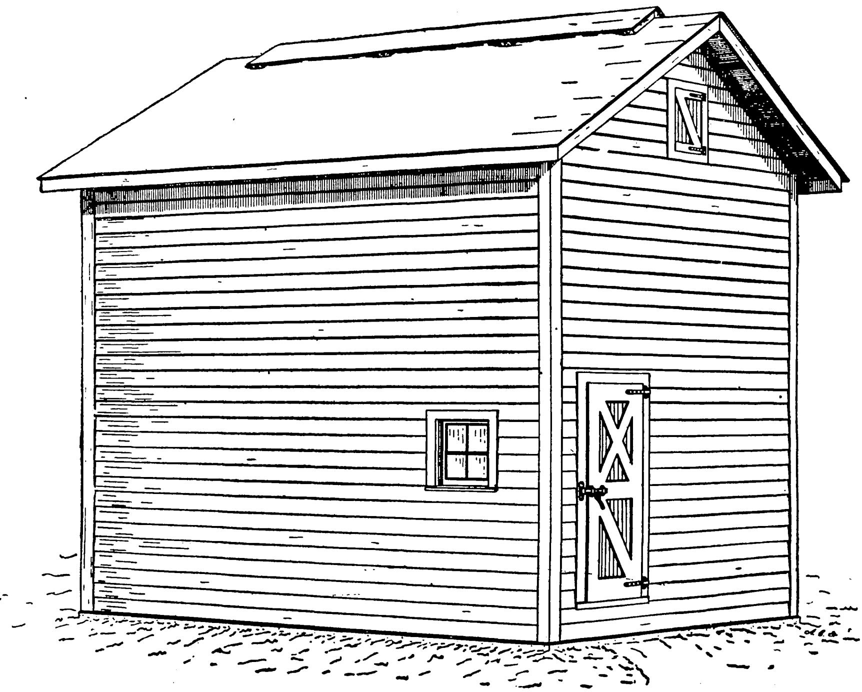


FIG. 20.—Wooden ice house, with milk room, insulated with sawdust or mill shavings. (Perspective view.)

**Roof.**—The roof is fitted with 1-inch roof boards covered with a good quality of shingles laid 4½ inches to the weather and securely nailed. Prepared roofing may be used instead of shingles, with good results.

**Doors.**—The doors are constructed as shown in the detail in figure 19a, and should be of a good quality of seasoned lumber. Commercial doors can be bought at a reasonable price and probably will be more satisfactory than those made by a carpenter inexperienced in this kind of work.

**Drainage.**—Thorough drainage is provided by a floor of 12 inches of cinders well tamped into place. If necessary either a drainage ditch or a porous tile, as described under post ice house, may be used.

**Ventilation.**—Ventilation is provided as shown in figure 19b.

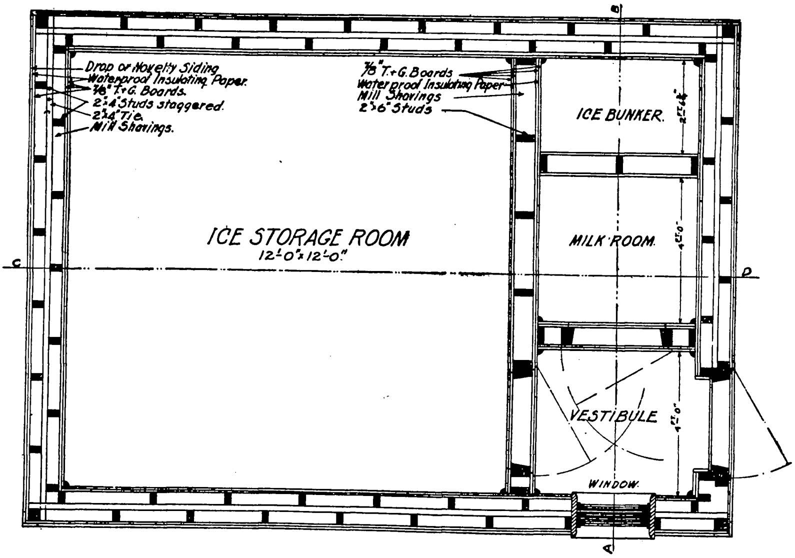



FIG. 20A.—Wooden ice house, with milk room, insulated with sawdust or mill shavings.

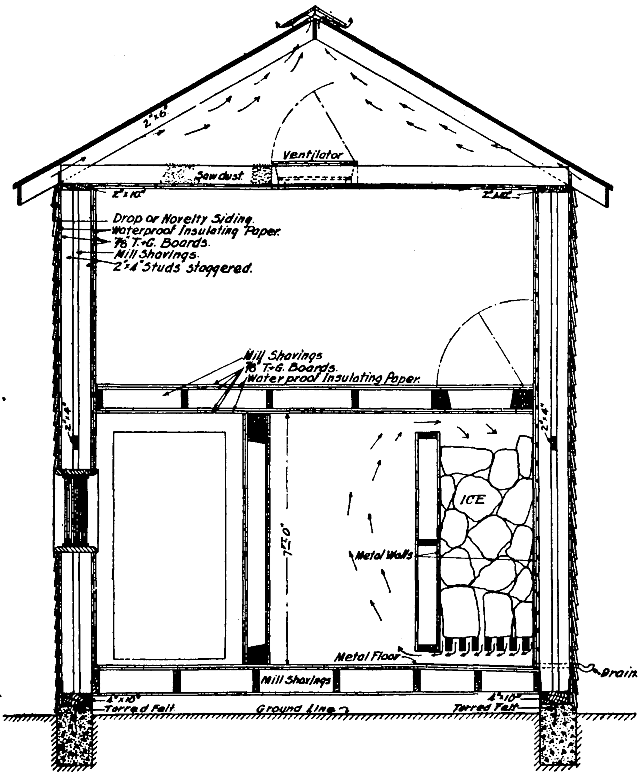



FIG. 20B.—Wooden ice house, with milk room, insulated with sawdust or mill shavings. (Section on *A–B* of fig. 20A.)

## FRAME ICE HOUSE WITH COMMERCIAL INSULATION.

**Floor.**—After excavating to a proper depth, depending on the character and lay of the soil, lay a 4-inch concrete base; cover this with hot asphalt, and lay directly on it 3 inches of good commercial insulation with all joints fitted. This in turn is covered with a layer of hot asphalt followed by a 2-inch layer of concrete. Finally finish with ½-inch Portland-cement mortar and smooth. The floor should incline 1 inch to 4 feet in the direction of the center drain.

**Walls.**—Set up 2 by 6 inch studs as shown in figure 21a and cover on the outside with drop or novelty siding. On the inside the studs should be covered with a course of ⅞-inch tongued-and-grooved boards followed by a layer of waterproofed insulating paper. Upon this securely nail to the wall 3 inches of good commercial insulation and follow with a ½-inch Portland-cement finish.

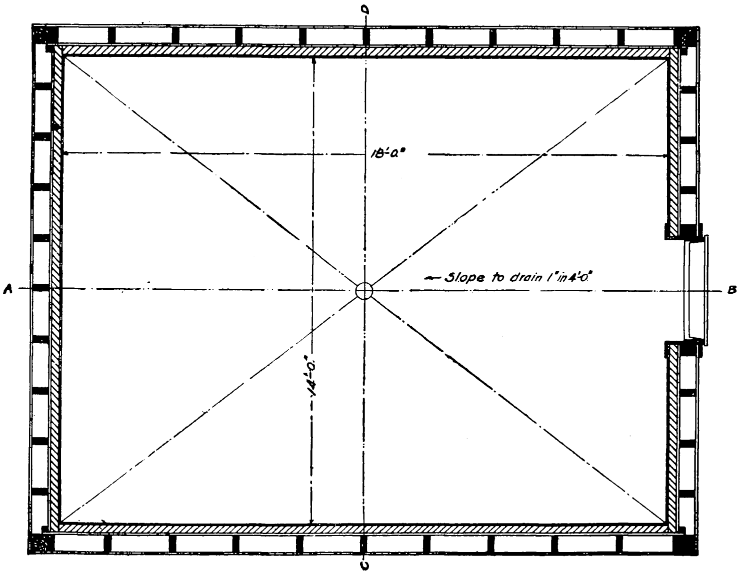



FIG. 21.—Frame ice house with commercial insulation. The perspective view in figure 19 also illustrates this plan. (Ground plan.)

The space between the studs is to be provided, as shown in figure 21a, with an opening at the top and bottom for the circulation of air.

**Ceiling.**—The ceiling is made of one course of ⅞-inch tongued-and-grooved boards nailed directly on the joists and then covered with one course of waterproofed insulating paper, followed with 2 inches of good commercial insulation, nailed directly to the ceiling. It is finished with ½-inch of Portland-cement plaster. For additional insulation a layer of dry sawdust from 6 to 12 inches may be placed on top of the ceiling.

**Roof and doors.**—The same type of roof and doors may be used as in the other ice houses.

**Drainage.**—The floor should slope 1 inch to 4 feet toward the center drain. A 3-inch glazed tile drain should lead from the center of the floor to a convenient point outside the building, with a sufficient fall to carry the water off. The drain must be properly trapped to prevent the entrance of warm air.

## A SMALL CONCRETE ICE HOUSE.

The building illustrated in figure 22 may be constructed of solid concrete or concrete blocks. The foundation trenches should be dug 10 inches wide and 2½ feet deep and filled with concrete in the proportion of 1 part Portland cement, 2½ parts sand, and 5 parts crushed rock. Above the ground level the walls may be made of either concrete blocks laid up in a 1 to 2 cement-sand mortar, or of solid concrete. For the solid walls above the ground level, the concrete should be proportioned 1 part Portland cement to 3 parts sand and 5 parts crushed rock, or 1 part cement to 6 parts of clean bank-run gravel. Bank-run gravel generally is not clean nor are the large and small aggregates in proper propor-

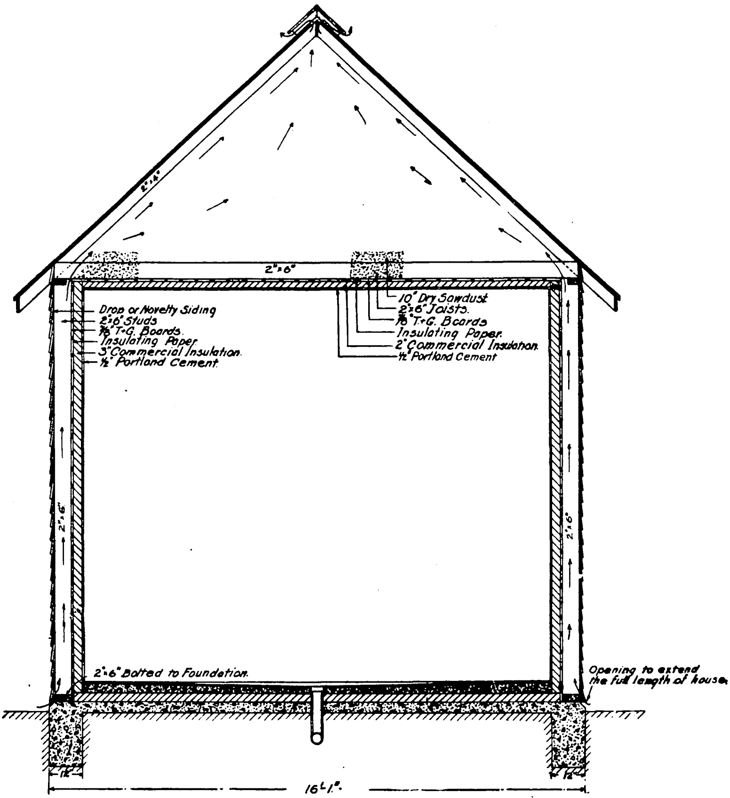



FIG. 21A.—Frame ice house with commercial insulation. (Section on *C–D* of fig. 21.)

tion. It should be screened and remixed in correct proportion, else the concrete may be of poor quality.

In building up the concrete walls, movable forms are used for holding the wet concrete in place until it hardens. The forms should be 3 feet high and should extend entirely around the building. After filling the forms with concrete it should be allowed to stand until it sets and then the forms may be loosened, moved up, and again filled.

Three-eighths-inch steel reinforcing rods, spaced 18 inches apart and running in both directions, should be placed in the freshly poured concrete. The rods should be arranged alternately or staggered so that half of them will be placed

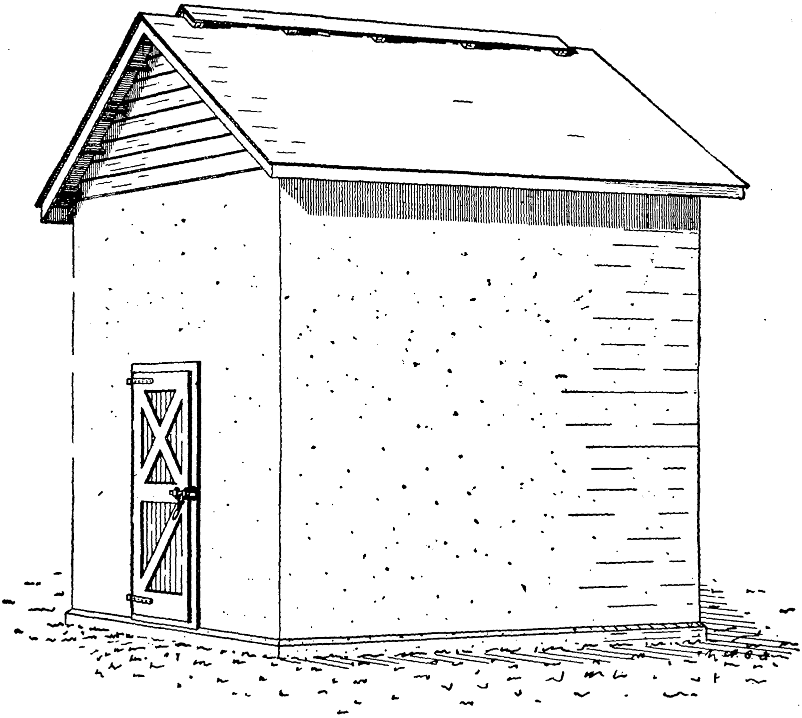


FIG. 22.—A small concrete ice house. (Perspective view.)

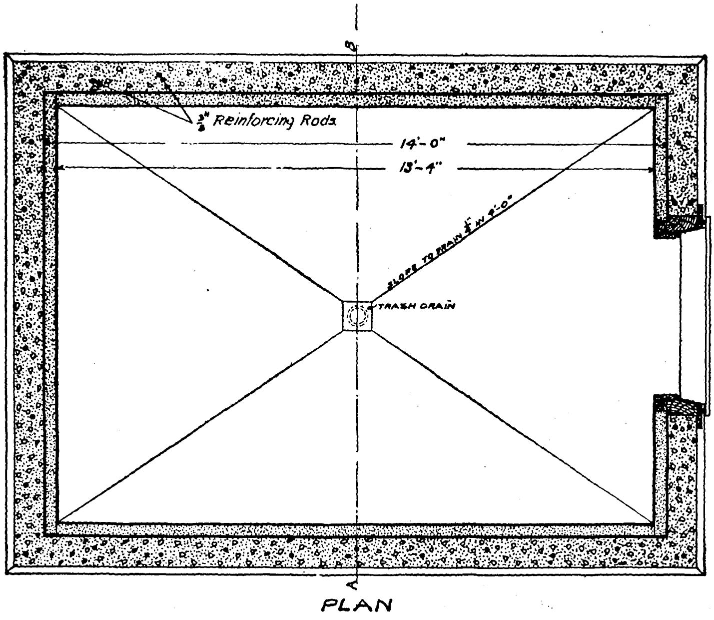



FIG. 22A.—A small concrete ice house.

3 inches from the outside edge and the other half 3 inches from the inside of the wall. In the concrete above the door opening, embed two rods or an old wagon tire cut in two and straightened. For holding the plates on top of the walls ½-inch bolts 10 inches long should be sunk head down 6 inches deep in the concrete. Concrete has very little value as insulation; hence in an ice house of this type it is necessary to use insulating material in the construction of the floor and walls.

The floor is made in layers. First 4 inches of concrete is laid on the ground. On top of the concrete 3 inches of cork-board insulation embedded in hot asphalt is placed, and this is followed with 2 inches of concrete, sloped 1 inch to 4 feet

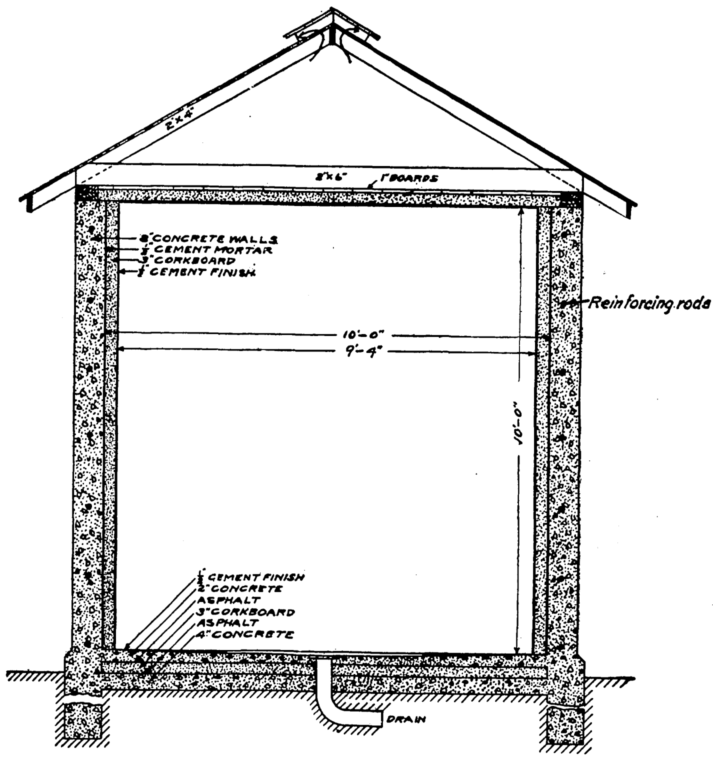



FIG. 22B.—A small concrete ice house. (Section on *A–B* of fig. 22a)

to the center drain. The floor should be finished smooth with ½-inch Portland-cement mortar.

Cork-board insulation is placed on the walls and ceiling in a ½-inch bed of Portland-cement mortar, mixed in the proportion of 1 part cement to 2 parts clean sand. Vertical joints should be broken and all joints made tight. A ½-inch Portland-cement finish is finally applied to the walls and ceiling as well as to the floor.

In many cases it is cheaper to crib the walls to their full height instead of using sectional forms, as a part of the form lumber can be used in the roof and ceiling and the remainder probably can be used to advantage on the farm.

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